DRAFT
1/9/2008

Summary of Draft Policy Analysis

Higher Hazard Substance: Perchloroethylene, Tetrachloroethylene, or PCE (CAS 127-18-4)

1. State of the Science

PCE has both acute and chronic adverse health effects. Acute effects can include skin, eye and respiratory irritation, depression of central nervous system function, headache, dizziness, nausea, incoordination, unconsciousness, and for very high exposures, death. IARC classifies PCE in Group 2A (probably carcinogenic to humans); other chronic effects may include liver, kidney or central nervous system damage. The developing fetus and children may be particularly vulnerable to the toxic effects of PCE.

2. Number of facilities affected

The TURA program estimates that the 1,000 pound reporting threshold that would apply to a higher hazard substance would affect 50 facilities.

3. Opportunities for New Filers

In both dry cleaning and vapor degreasing, purchasing the newest generation of technology makes it possible to reduce PCE use dramatically. In addition, practical alternatives to PCE are available for most uses. These include both process changes and material substitutions.

- For garment cleaning, alternatives include a variety of solvents (material substitutions), as well as carbon dioxide and wet cleaning (process changes).
- For vapor degreasing, both drop-in substitutes and process changes are possible. Several drop-in replacement solvent alternatives are available, although they pose significant health and environmental concerns. Aqueous systems are a feasible alternative to many solvent-based vapor degreasing operations. Other options include process changes, such as working within the supply chain to eliminate the need for degreasing.
- Alternatives for brake cleaning include both drop-in substitutes and process changes (aqueous parts washers).

4. Regulatory context

At the federal level, PCE is a reportable TRI chemical, and is listed as a hazardous air pollutant and regulated via specific emission standards for dry cleaning, under the Clean Air Act, among other provisions. Under a new EPA rule, dry cleaning facilities that are colocated with residential units will be required to cease use of PCE by 2020. At the state level, California regulates PCE as a carcinogen under Proposition 65. In addition, all professional cleaners in California will be required to be PCE-free by 2023; and the use of chlorinated solvents in vehicle repair is illegal in California as of 2002. PCE is recognized as a priority internationally as well. In Massachusetts, the Department of Environmental Protection has a successful program working with dry cleaners through the Environmental Results Program. Massachusetts restrictions on discharges to septic systems could be a limitation for some cleaners in shifting to safer alternatives.

5. Implications for the TURA program

The TURA program is in a good position to offer services to new filers interested in reducing or eliminating their use of PCE. The program has substantial experience in and expertise on PCE alternatives, and is actively engaged in working with users to reduce or eliminate use of this substance. In addition, listing PCE as a higher hazard substance would communicate consistent information to industry, and ensure that the program does not encourage facilities to shift from TCE to PCE.

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Draft Policy Analysis

Higher Hazard Substance: Perchloroethylene, Tetrachloroethylene, or PCE (CAS 127-18-4)

The Science Advisory Board has recommended listing perchloroethylene (also known as tetrachloroethylene, perc, or PCE) as a higher hazard substance under TURA. With this listing, the reporting threshold for PCE use would be lowered to 1,000 lb/year for companies in TURA covered industry sectors with ten or more employees. New companies entering the program under the lower reporting threshold would be required to file annual toxics use reports, pay annual toxics use fees, and develop a toxics use reduction plan every two years. In addition, the TURA program would prioritize PCE in allocating program resources, ensuring that companies receive targeted assistance in reducing or eliminating use of this chemical.

This policy analysis summarizes key scientific information on PCE; estimates the number of facilities that are likely to enter the program as a result of the lower reporting threshold; analyzes opportunities and challenges that are likely to face new filers; and discusses the implications of this policy measure for the TURA program. Based on this analysis, the Toxics Use Reduction Institute supports the SAB's recommendation that PCE be listed as a higher hazard substance.

1. **State of the Science**

PCE has serious adverse effects on human health, including both acute and chronic health effects. PCE most often enters the environment through fugitive emissions from dry cleaning and metal degreasing operations and by spills or accidental releases to air, soil or water. Exposure results from environmental contamination, presence in consumer products or occupational sources. [1] For a list of specific data points considered by the SAB in developing its recommendation, see Appendix A.

Acute toxicity

- Short term exposure to PCE can cause symptoms including skin, eye and respiratory irritation, depression of central nervous system function, headache, dizziness, nausea, incoordination, and unconsciousness. Very high exposure can be lethal.[2]

Chronic toxicity

- The International Agency for Research on Cancer classifies PCE in Group 2A (probably carcinogenic to humans).[3] The US National Toxicology Program classifies PCE as "Reasonably anticipated to be a human carcinogen."[4]
- A recent Massachusetts-based research project on Cape Cod looked at PCE exposure through contaminated drinking water and found an association between PCE exposure and cancer rates.[5]
- Exposure to PCE may cause liver, kidney or central nervous system damage. Some studies suggest that long term exposure to organic solvents such as PCE may cause lasting and possibly permanent central nervous system effects. Fatigue, lack of muscle coordination, loss of concentration, short term memory loss, and personality changes exhibited as

nervousness, anxiety or irritability are some of the potential long-term effects of chronic and frequent exposure.[6]

- The developing fetus and children may be particularly vulnerable to the toxic effects of PCE.[7] PCE inhaled by pregnant women can cross the placenta, causing exposure of the developing fetus, and has been found in breast milk of mothers exposed to the chemical.[8]

Uncertainty

Substantial information is available regarding both acute and chronic health effects. Uncertainty does not play a significant role in the development of our recommendations for this substance.

2. Number of facilities affected

PCE is the most widely used garment dry cleaning solvent in Massachusetts and nationally. Other major uses are as a metal degreaser, a chemical intermediate and an ingredient in consumer products, such as automotive aerosol parts cleaners and degreasers. PCE is used less often than trichloroethylene (TCE) for vapor degreasing, but is still used in significant quantities.

In consumer aerosol products, PCE may serve as a solvent in a cleaner or spotting agent, or as a carrier in a glue, adhesive, lubricant or car detailing product. The principal use of PCE-based aerosols in the automotive industry is for brake cleaning, although this use has declined.

a. Historical data on sectors using PCE in Massachusetts

Historically, PCE has been reported under TURA by the sectors listed below.

2261	Finishing plants, cotton
2671	Packaging paper and plastics film
2754	Commercial printing, gravure
2759	Commercial printing
2796	Platemaking services
2869	Industrial organic chemicals
2891	Adhesives and sealants
2899	Chemical preparations
3052	Rubber and plastic hose and belting
3315	Steel wire and related products
3354	Aluminum extruded products
3398	Metal heat treating
3471	Plating and polishing
3479	Metal coating and allied services
3498	Fabricated pipe and fittings
3499	Fabricated metal products
3674	Semiconductors and related devices
3675	Electronic capacitors

3714	Motor vehicle parts and accessories
3822	Environmental controls
3851	Ophthalmic goods
5169	Wholesale Trade - Chemicals and allied products
7216	Dry cleaning plants (except rug)
7218	Industrial launderers
7389	Business services

b. Current data on PCE use in Massachusetts

In 2005, the most recent year for which data are available, four companies reported use of PCE. In SIC code 5169, "wholesale trade - chemicals and allied products, not elsewhere classified," two companies process PCE. In SIC code 2899, "chemical preparations," one company processes PCE for "custom blending of raw material, packaging, adding propellant to aerosols," in the production of "aerosol liquid and powder products." In SIC code 3471, "plating and polishing," one company "otherwise uses" PCE (using it for "masking of parts for electroplating").

c. Estimated number of companies that would be affected by a lower reporting threshold

To develop an estimate of the number and type of companies likely to be affected by a 1,000 lb reporting threshold for PCE, the Institute consulted sources including the TURA data; facilities reporting under EPCRA Tier II requirements; Clean Air Act Hazardous Air Pollutant permits; RCRA hazardous waste permits; and dry cleaning facilities included in the MassDEP Environmental Results Program (ERP). In addition, staff at the Office of Technical Assistance (OTA) and the TURI Surface Solutions Laboratory developed estimates based on their experience working with industry. Based on these sources, OTA and TURI staff estimate the following impact:

- 2891(Adhesives & Sealants), 3081 (Plastic Film & Sheet), 7216 (Dry Cleaning Plants) and 7218 (Industrial Launderers) are most likely to be affected, with 7 to 15 filers each.[9]
- The following sectors are expected to generate between one and five filers each: 2269 (Finishers of Textiles), 27xx (Printing, Publishing, and Allied Industries), SICs 2813 (Industrial Gases), 2899 (Chemical Preparations), 3052 (Rubber & Plastic Hose and Belting), 347x (Coating, Engraving, and Allied Services), 349x (Fabricated Metal Products), 3567 (Industrial Process Furnaces and Ovens), 367x (Electronic Components and Accessories), 4226 (Special Warehousing and Storage), 5169 (Wholesale Trade - Chemicals and Allied Products).
- The following sectors are not likely to be affected: 29xx (Petroleum refining and related industries), 33xx (Primary metal industries), 3451 (Screw Machine Products), 3499 (Fabricated Metal Products), 3675 (Electronic Capacitors), 4953 (Refuse Systems).

Based on this information, we estimate that a 1,000 lb reporting threshold would affect between 40 and 70 filers. This would include some facilities that are already familiar with the program, and some that are new to the program.

3. Opportunities for New Filers

Feasible alternatives are available for most uses of PCE. In the discussion below, we briefly review trends in PCE use among existing TURA filers. We then consider the known alternatives for some of the most common uses of PCE.

a. Trends in PCE use

PCE use reported under TURA has decreased significantly since the program's inception. In 1990, 16 TURA filers reported PCE use; by 2005, only 4 reported PCE use. There has been a 73% reduction in reported PCE use from 1990 to 2005, and a 96% reduction in reported PCE releases from 1990 – 2005 (figures not adjusted for changes in production levels).

Table 1. Massachusetts PCE Use and Release Data: 1990 and 2004 (figures not adjusted for production)

	Year		Change in lbs	% Change
	1990	2005		
PCE used (lbs)	991,393	268,505	-722,888	-73%
PCE Released (lbs)	298,518	10,775	-287,743	-96%

In addition to the information available from the TURA data, some quantitative information is available regarding PCE use in garment cleaning. There are over 550 dry cleaning facilities in Massachusetts.[10] As of 2005, these facilities used approximately 990,000 lb of PCE annually, generating 600,000 pounds of hazardous waste.[11]

b. Opportunities to reduce PCE use[12]

In both dry cleaning and vapor degreasing, purchasing the newest generation of technology makes it possible to reduce PCE use dramatically. In addition, alternatives to PCE are available for most applications. These alternatives include both process changes and material substitutions.

i. Alternatives for Garment Cleaning

Newer PCE dry cleaning equipment (4th and 5th generation) uses a closed system to minimize loss through evaporation, making it possible to reduce total use of PCE dramatically compared with older technologies. In addition, a number of alternative chemicals and processes are currently available, making it possible for professional garment cleaners to replace PCE entirely. These include both solvent-based alternatives (material substitutions) and non-solvent based alternatives (process change).

- Solvent-based alternatives to PCE in garment cleaning include hydrocarbon-based systems; volatile methyl siloxane; and substituted aliphatic glycol ethers. Of these, the hydrocarbon-based systems are most widely used. Some health and environmental concerns exist about each of these solvent-based systems, and key toxicological data are lacking for some of them.[13] Most solvent-based alternatives have been designed for use with different equipment from that used for PCE cleaning; some can be used in PCE machines with minor modifications.

- Non-solvent based alternative dry cleaning systems currently on the market include carbon dioxide and wet cleaning. Adopting these systems requires purchasing new equipment and additional training.
    - Liquid carbon dioxide is used with specialized equipment to clean garments. Typically, liquid CO_2 is maintained under a pressure of 700 pounds per square inch and uses detergents specifically designed for this process. CO_2 cleaning equipment has significantly higher up-front purchase costs compared with PCE equipment.
    - Wet cleaning processes rely on water, detergent, conditioners and/or degreasers to clean the garment. These processes may use specialized equipment to regulate temperature, minimize agitation, and to maintain integrity of fabrics. Wet cleaning equipment has somewhat higher up-front purchase costs compared with PCE equipment.

ii. Vapor Degreasing

Alternatives to PCE for vapor degreasing include either drop-in substitute solvents, or a process change (conversion to aqueous cleaning).

Drop-in substitutes: Many alternative solvents have been tested for performance in TURI's Lab and elsewhere. Effective drop-in replacement solvent alternatives include n-propyl bromide (nPB), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), hydrofluoroether (HFEs) and volatile methyl siloxanes (VMSs). Health and environmental concerns exist about each of these options; depending on the substance, these include reproductive toxicity, central nervous system effects, and global warming potential.[14] These drop-in substitutes have purchase costs that range from 3 to 43 times greater than that of PCE on a per gallon basis. Some savings may be achieved through lower operating temperatures.

Process change: Aqueous systems are a feasible alternative to many solvent-based vapor degreasing operations, although they may involve additional process time and capital investment. Each company's cleaning needs are unique and cleaning processes should be specifically tailored for those needs.

From a health and environmental standpoint, the best alternatives to PCE for vapor degreasing are:

- Switching to an aqueous or semi-aqueous system;
- Working within the supply chain to change the contaminant on the part that requires cleaning; or
- Investigating a materials change to prevent contamination and cleaning altogether.

iii. Automotive Aerosols

Alternatives for brake cleaning include drop-in substitutes (aerosol products that do not contain PCE), and process changes (aqueous parts washers).

Drop-in substitute: Both solvent-based and aqueous products are available as drop-in substitutes for PCE brake cleaners. The TURI Lab has conducted performance testing on alternative aerosol brake cleaners. Preliminary results indicate that these alternative brake cleaning aerosols have equivalent performance, and are cost comparable, to the PCE based products.

- Many solvent mixtures can be aerosolized and used for brake and automotive parts cleaning or degreasing. Main components in some of the cleaners found on the market are heptane,

C9-C12 hydrocarbons, toluene and xylene. Many of these alternatives also pose significant health and safety hazards. Toluene and xylene are TURA listed chemicals.

- Aqueous aerosolized products have also proven to be effective, and pose fewer health and environmental concerns than any of the solvent-based products.

Process change: Aqueous parts cleaners have also proven to be effective as a process change for aerosol products.

iv. Lessons from California: Model Program for Professional Garment Cleaners

The most successful model for promotion of safer garment care is found in California, where the state has worked actively to promote the adoption of carbon dioxide and wet cleaning technologies. As a result, California currently leads the nation in use of these alternative garment cleaning processes.

California provides direct grants to cleaners to assist them in purchasing state-of-the-art CO_2 or wet cleaning equipment. Grant recipients commit to becoming dedicated facilities (using CO_2 or wet cleaning for 100% of garments). Grant recipients also serve as demonstration sites, allowing other cleaners to learn about these alternative technologies from colleagues.

In addition, the Pollution Prevention Center at Occidental College provides extensive training opportunities for garment cleaners that are interested in making, or have made, the shift.[15] Data from the California demonstration projects indicate that wet cleaning offers numerous advantages. Facilities that converted to wet cleaning have been able to maintain their level of service and customer base, while increasing energy efficiency and lowering operating costs.[16]

Appropriate equipment and adequate training are essential for success in converting to wet cleaning. Equipment upgrades and modifications within the past decade have made it possible to use wet cleaning for 100% of garments. Cleaners that shift to wet cleaning through the California program receive several days of training, making it possible for them to work as efficiently with wet cleaning equipment as they would with PCE equipment.

c. Implementation: Opportunities and challenges

The services of the Office of Technical Assistance and staff at TURI's Surface Solutions Laboratory (SSL) will be a major factor facilitating the transition from PCE to safer alternatives. Both OTA and the SSL have extensive experience providing assistance to facilities working to replace chlorinated solvents with safer alternatives, and are engaged in on-going projects to help users identify alternatives that are appropriate to their specific needs.

Smaller users working to reduce or eliminate PCE use could face financial challenges in cases in which an up-front capital investment is necessary to shift to a safer alternative. In these cases, subsidies and grant programs can facilitate the transition.

For cases in which a process change is involved, training programs and demonstration sites can help to provide facilities with the opportunity to explore and evaluate new options. For example, a small subsidy to auto shops can provide them with a cost-free trial period to experiment with using aqueous parts cleaners. In the case of dry cleaning, California has developed an extensive system of

alternative garment cleaning demonstration sites that facilitate information transfer among garment cleaners.

Existing regulations present a complicating factor for garment cleaners that currently discharge to a septic system. In Massachusetts, the discharge from a commercial wet cleaning machine is considered industrial wastewater (IWW). Discharge of IWW to a septic system is prohibited.[17] Therefore, any discharge from a wet cleaning operation to ground requires an IWW groundwater discharge permit.[18] As a result, there is little regulatory incentive for cleaners on septic systems to move to wet cleaning. Such a transition would simply shift these facilities' regulatory responsibilities from hazardous waste management to groundwater discharge permitting.

4. Regulatory context

Due to its toxicity, PCE is subject to extensive regulation at the federal, state, and international level.[19] For a glossary of regulations referred to in this section, see Appendix B.

EPCRA	• Reportable TRI chemical[20] • Subject to US EPA Tier II reporting requirements[21]
CAA	• Hazardous air pollutant[22] • Subject to NESHAP (MACT) emissions standards for dry cleaning, halogenated solvent cleaning, and other applications[23]
RCRA	• Considered hazardous as a spent solvent[24]
CERCLA	• 100 lb reporting threshold[25]
OSHA PEL (TWA)	• 100 ppm
ACGIH TLV (TWA)	• 25 ppm
ACGIH TLV-STEL	• 100 ppm
SDWA	• MCL for PCE in drinking water = 0.005 mg/L[26]

In addition, new EPA air toxic requirements include a phase-out of PCE dry cleaning machines located in residential buildings. By 2020, dry cleaning machines in residential buildings will be prohibited from using PCE.

Massachusetts:

Occupational	• Subject to Right-to-Know requirements[27]
Environmental & Public Health	• The 24-hour acceptable ambient air exposure limit for PCE is 136 ppb while the annual acceptable exposure limit is 0.003 ppb.[28]
Other relevant requirements	• Dry cleaners are included in DEP's Environmental Results Program. • Under Massachusetts regulations, if a cleaner on a septic system were to convert to wet cleaning, the facility would be required to obtain an industrial wastewater groundwater discharge permit (see discussion under "implementation: opportunities and challenges," above).

In Massachusetts, the dry cleaning sector is regulated under the Environmental Results Program (ERP). ERP is an environmental performance initiative that replaces facility-specific state permits with industry-wide environmental performance standards and annual compliance certifications. ERP provides the following tools to the sectors it oversees:

- Self-certification of compliance by companies to increase self evaluation and accountability (this is an annual process, but frequency can be decreased if warranted by improved sector performance);
- Compliance assistance through outreach and sector workbooks; and
- A new performance measurement methodology to track results, determine priorities and strategically target inspections and compliance assistance efforts.

The Massachusetts Department of Environmental Protection has drafted amended PCE dry cleaning regulations to incorporate the new federal standards for co-residential facilities. The proposed regulation would expand the federal definition of co-residential to include additional "sensitive receptors" such as day care centers, schools and health care facilities.

Other state regulations

California regulates PCE under the Safe Drinking Water and Toxics Enforcement Act of 1986 (Proposition 65).[29] Nationally, California is a leader in efforts to eliminate PCE use in specific applications (vehicle repair and garment cleaning). All professional cleaners in California will be required to be PCE-free by 2023. [30] California levies a fee on all PCE used. Funds collected through this fee are used to help cleaners make the transition to wet cleaning and carbon dioxide cleaning systems. In addition, "sale of automotive repair products containing perchloroethylene, methylene chloride, or trichloroethylene are prohibited in California, effective as of June 2001; use is prohibited, effective as of December 2002."[26]

The New Jersey Department of Environmental Protection has proposed amendments to existing regulations. The proposed new regulations would prohibit use of perchloroethylene in dry cleaning facilities that are located in residential buildings, effective July 2009. Perchloroethylene would be eliminated from all dry cleaning by 2021.[31]

International:

- PCE is on Priority List 1 of Canada's Domestic Substances List categorization.[32]
- In the European Union, perchloroethylene is on the High Production Volume Chemicals Priority List 1. Chemicals identified as priorities in this and other list will also be prioritized under the new European chemicals regulation, REACH.
- The Swedish Chemical Products Ordinance of 1998 bans the sale of products containing chlorinated solvents (methylene chloride, trichloroethylene, or PCE) for private use by consumers.[33]

5. Implications for the TURA program

The TURA program is in a good position to offer services to new filers interested in reducing or eliminating their use of PCE. The program has substantial experience with and expertise on PCE alternatives, and has a history of working successfully with users on these issues.

Activities of both TURI and OTA already provide infrastructure which could help smaller users to reduce their use of PCE. Several on-going program activities would help meet the demand for services.

- In 2007, the TURA program designated TCE as a higher hazard substance. Since PCE may be used interchangeably with PCE in a variety of applications, designating PCE as a higher hazard substance as well will communicate a consistent message to users of both TCE and PCE. Listing TCE as a higher hazard substance without listing PCE in the same status could lead to unintended consequences, motivating TCE users to shift to PCE.
- Both the Office of Technical Assistance and the Institute's Surface Solutions Laboratory (SSL) has significant experience helping both large and small users to identify safer alternatives to both TCE and PCE and is available as a resource for new filers entering the program. The SSL has conducted solvent cleaning alternative testing since 1993, assisting hundreds of businesses in making the transition to less toxic alternatives without compromising performance.
- The Department of Environmental Protection has a well established and successful Environmental Results Program that has brought garment cleaners into compliance with existing regulations, improved communication with cleaners, and facilitated information gathering about this sector. Building on the relationships that have been formed through this program, the Department is well situated to help garment cleaners comply with and reap the benefits of the TURA program.
- The Institute's community grant program has worked with auto shops; one past grantee, the Safe Shops project of the Boston Public Health Commission (BPHC), now has significant capacity and expertise for providing training and technical assistance for auto shops wishing to shift to safer alternatives for brake cleaning. The BPHC Safe Shops project has also developed excellent outreach materials, which the program could use in future outreach.
- The Institute has well-established relationships with professional garment cleaners in the Commonwealth, and funded the creation of a wet cleaning demonstration site in the late 1990s. Wet cleaning equipment has evolved significantly since that time, and the Institute is currently working to facilitate adoption of wet cleaning by additional facilities. The Institute's services in this area include dissemination of educational materials, and demonstration events showcasing state of the art equipment. In fiscal year 2008, the Institute will provide a direct equipment purchase grant to one cleaner that currently uses PCE, allowing the cleaner to create a dedicated wet cleaning facility. In future years, the Institute plans to continue providing a range of services to dry cleaners.
- Both the OTA and TURI have conducted studies that help to inform their on-going work with PCE users. In 2005, the Office of Technical Assistance published the results of a survey on barriers to substituting chlorinated solvents.[34] In 2006, the Institute completed a detailed study of selected uses of PCE and their alternatives as part of its Five Chemicals Alternatives Assessment report.[35]

There would be some additional cost to companies that would begin reporting PCE based on a lower reporting threshold, including preparing annual toxics use reports and biennial toxics use reduction plans, and paying toxics use fees. The average base fee paid by TURA filers in 2006 was

$3,425. However, most new filers for PCE are likely to be facilities with less than 50 employees. The base fee for this size facility is $1,850. Some filers would not be new to the program and already pay a base fee, but would begin to pay a per chemical fee of $1,100.

Thus, the additional cost in fees to filers (and revenue to the program) could be $44,000 to $77,000 in per chemicals fees (40 to 70 filers for PCE) plus an estimated $55,500 (base fee for 30 small sized companies reporting PCE only).

6. Summary

PCE is recognized as a priority toxic chemical at the international, national, and state levels. The US EPA and the State of California have taken leadership roles in encouraging PCE users to adopt safer alternatives. Designating PCE as a higher hazard substance will make it possible to extend the benefits of the TURA program and TURA planning to a wider community of users. A range of services would be available to the regulated community; these include training in TUR planning methods, assistance in identifying safer alternatives for specific uses, and in some cases, direct grants for capital investments in new equipment. By expanding the regulated universe for PCE at the state level, Massachusetts will be in a better position to help PCE users comply with new regulations at the national level. For the dry cleaning sector, it may be appropriate to integrate these efforts with DEP's successful Environmental Results Program.

Appendix A: Data the SAB considered for PCE

International Agency for Research on Cancer (IARC)	At the time of consideration by SAB, listed in Group 2B (possible human carcinogen); now upgraded to Group 2A (probable human carcinogen).
PBT Profiler:	
Half life in water	60 days
Half life in soil	120 days
Half life in sediment	540 days
Half life in air	96 days
Bioconcentration factor	83
Chronic fish ChV (mg/l)	Not estimated, but expected to be toxic to fish
ATSDR Minimum Risk Level: acute inhalation	0.2 ppm
ATSDR Minimum Risk Level: chronic inhalation	0.04 ppm
ATSDR Minimum Risk Level: acute oral	0.05 mg/kg/day
OSHA PEL (TWA)	100 ppm
ACGIH TLV (TWA)	25 ppm
ACGIH TLV-STEL	100 ppm
LD50 (mg/kg) – oral rat	2629
LC50 (mg/m^3) – mouse	35.3
RfD (mg/kg/day)	0.01

Appendix B: Glossary of Regulatory Terms & Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
EPCRA	Emergency Planning and Community Right to Know Act
ERP	Environmental Results Program
FDA	Food and Drug Administration
MACT	Maximum Achievable Control Technology
MCL	Maximum Contaminant Level
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institutes of Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RfD	Reference Dose
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
STEL	Short Term Exposure Limit
Tier II	Chemical inventory reporting requirements for facilities subject to EPCRA
TRI	Toxic Release Inventory
TWA-PEL	Time-weighted average - Permissible Exposure Limit
TWA-REL	Time-weighted average – Recommended Exposure Limit
TWA-TLV	Time-weighted average - Threshold Limit Value

[1] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Tetrachloroethylene (PERC)*, September 1997, available at http://www.atsdr.cdc.gov/toxprofiles/tp18.html, viewed January 2008.
[2] Office of Pollution Prevention and Toxics, US Environmental Protection Agency, "Chemical Summary for Perchloroethylene," (August 1994), EPA 749-94-020a, available at http://www.epa.gov/chemfact/s_perchl.txt; Agency for Toxic Substances and Disease Registry, "ToxFAQs for Tetrachloroethylene (PERC)," September 1997, available at http://www.atsdr.cdc.gov/tfacts18.html#bookmark05.
[3] International Agency for Research on Cancer (IARC), "Overall Evaluations of Carcinogenicity to Humans: Group 2a: Probably Carcinogenic to Humans: Agents and Groups of Agents," available at http://monographs.iarc.fr/ENG/Classification/crthgr02a.php, viewed January 2008.
[4] National Toxicology Program, *11th Report on Carcinogens,* Chapter IIB: Carcinogens Listed in the Eleventh Report: Reasonably Anticipated to be Human Carcinogens," Available at http://ntp.niehs.nih.gov/ntp/roc/eleventh/reason.pdf, viewed January 2008.
[5] Aschengrau, A., Rogers, S. & Ozondoff, D. 2003, "Perchloroethylene-contaminated drinking water and the risk of breast cancer: Additional results from Cape Cod, Massachusetts, USA", Environmental Health Perspectives, vol. 111, no. 2, pp. 167-173
[6] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Tetrachloroethylene (PERC)*, September 1997, available at http://www.atsdr.cdc.gov/toxprofiles/tp18.html, viewed January 2008; California Department of Health Services, Hazard Evaluation System and Information Service, "Fact Sheet: Perchloroethylene (tetrachloroethylene or "perc"), 1989.
[7] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Tetrachloroethylene (PERC)*, September 1997, available at http://www.atsdr.cdc.gov/toxprofiles/tp18.html, viewed January 2008.
[8] Agency for Toxic Substances and Disease Registry, *Toxicological Profile for Tetrachloroethylene (PERC)*, September 1997, available at http://www.atsdr.cdc.gov/toxprofiles/tp18.html, viewed January 2008.
[9] The ERP program estimates that 250 to 300 professional garment cleaners use 1,000 lb or more of PCE annually. However, most of these cleaners are likely to fall below the ten employee threshold. Information on number of employees is available for selected facilities in the Harris Selectory database; however, the database lists a total of only 47 cleaners, limiting the utility of this resource. In addition, some listings may represent companies with more than one facility.Of the cleaners listed in the Harris Selectory, 26 have more than 10 employees and are on the ERP list of PCE users.
[10] Massachusetts Toxics Use Reduction Institute, *Five Chemicals Alternatives Assessment Study* (June 2006), available at http://www.turi.org/library/turi_publications/five_chemicals_study.
[11] Massachusetts Toxics Use Reduction Institute, *Five Chemicals Alternatives Assessment Study* (June 2006), citing S. Peck, "Dry Cleaning," Massachusetts Department of Environmental Protection, Environmental Results Program, 2005. (Facilities used over 73,000 gallons of PCE; converted at 13.5 lb/gal.)
[12] Unless otherwise noted, information in this section is drawn from the Toxics Use Reduction Institute Chemical Fact Sheet on Perchloroethylene (PCE), 2007, available at http://www.turi.org/library/turi_publications/chemical_fact_sheets.
[13] Massachusetts Toxics Use Reduction Institute, *Five Chemicals Alternatives Assessment Study* (June 2006), available at http://www.turi.org/library/turi_publications/five_chemicals_study. The substances used in the hydrocarbon-based and volatile methyl siloxane systems are not listed under TURA. The manufacturers have not provided specific information on the chemical names of the substituted aliphatic glycol ethers.
[14] Massachusetts Toxics Use Reduction Institute, *Five Chemicals Alternatives Assessment Study* (June 2006), available at http://www.turi.org/library/turi_publications/five_chemicals_study.
[15] See Occidental College, Urban and Environmental Policy Institute, Pollution Prevention Center, information available at http://departments.oxy.edu/uepi/ppc/. The pollution prevention center maintains a list of cleaners that offer wet and CO_2 cleaning. Nearly 100 cleaners are listed as "dedicated facilities," meaning that they offer only wet or CO_2 cleaning. List of cleaners available at http://departments.oxy.edu/uepi/ppc/cleaners_list.htm, viewed January 2008.
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